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REPORT OF THE MERCURY ADVISORY COMMITTEE OF THE ENVIRONMENTAL PROTECTION AGENCY TO THE ADMINISTRATOR

Environmental Protection Agency
Washington, D. C.

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REPORT OF THE MERCURY ADVISORY COMMITTEE

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TO THE ADMINISTRATOR

Submitted for the
Mercury Advisory Committee
of the Environmental Protection
Agency

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DEPARTMENT OF PHARMACOLOGY
AND THERAPEUTICS

6 July 1971

William D. Ruckelshaus
Administrator
Environmental Protection Agency
1626 K Street, N.W.
Washington, D. C. 20460

Dear Mr. Ruckelshaus:

Your Mercury Advisory Committee has completed its report. If we can help further please feel free to call upon us.

Sincerely,

Edward J. Cafruny, M.D., Ph.D.
Chairman, Mercury Advisory
Committee

EJC.m

EPA-540/1-71-003

INTRODUCTION

On receipt of notices of cancellation of registration of Algimycin 200, Algimycin 300, and Industrial Algimycin MT-4, the registrant, Great Lakes Biochemical Company, exercised its rights (under Section 4.c. of the Federal Insecticide, Fungicide, and Rodenticide Act) to request that an advisory committee review the cancellation action. A Mercury Advisory Committee was appointed by William D. Ruckelshaus, Administrator of the Environmental Protection Agency. The committee reviewed published literature and considered all relevant factors pertaining to its charge. Members then assembled in Washington, D. C. on May 3-4, 1971. During these two days, the committee met with representatives from Great Lakes Biochemical, expert witnesses, and representatives of various governmental agencies. On completion of these hearings, the Mercury Advisory Committee considered all relevant factors and prepared to submit recommendations to the Administrator of the Environmental Protection Agency.

The committee's recommendations are contained in this report which comprises

Section I - Summary

Section II - Efficacy of Mercurial Algicides and Non-mercurial Substitutes

Section III - Risks to Handlers and Swimmers

Section IV - Contribution to Environmental Pollution and the Need for Control

Section V - Appendix A - Members of the Mercury Advisory Committee

Appendix B - Discussants at May 3 and 4 meeting

Appendix C - EPA staff at May 3 and 4 meeting

Appendix D - Special Exhibits

1. List of chemical algicides
2. Letter from Mr. McNew, Managing Director of the Boyce Thompson Institute for Plant Research, Inc.
3. Letter from Dr. Robert G. Tardiff, Chief, Toxicology Division of Water Hygiene

Section I - Summary

The Mercury Advisory Committee disapproves the use of Algimycin products which contain mercury. Accordingly, it recommends that the cancellation of registration of Algimycin 200 and Algimycin 300, July 22, 1969, and Industrial Algimycin MT-4, August 7, 1970 be sustained. As a basis for this recommendation, the committee cites three major points:

1. Effective substitutes which do not contain mercury are available.
2. Although algicides containing phenylmercuric compounds have not permanently injured or killed swimmers or handlers of such compounds, there are not enough data in the open literature to warrant the conclusion that mercurial algicides are free of risk. Granted that any risk involved is generally of a low order, there are certain groups (e.g., people with renal disease, others with various infirmities) who may be especially susceptible to the deleterious effects of mercurial compounds. Moreover, the hazards of long-term exposure over periods of years have not been weighed.
3. Phenylmercuric compounds added to swimming pools or water cooling towers do not remain confined at loci of addition. Sooner or later, mercurial residues are disseminated widely into the soils and waters of the earth. As mercury levels in the environment rise, men and beneficial animals

must suffer the consequences of mercurial toxicity. Since it has been clearly shown that free mercuric ion is released in the tissues of vertebrates injected with phenylmercurials and that bacteria can convert inorganic mercury to methyl mercury, the toxicity of phenylmercurials in the pharmacological sense cannot be separated entirely from the lesser or greater toxicity of its conversion products. It is important to note that the metabolic fate of phenylmercurial compounds added to swimming pools or water cooling towers is entirely unknown. The possibility that bacteria or algae in pools alter the chemical form of the added mercury has not been excluded.

The Mercury Advisory Committee considers point 3 above to contain the most cogent and compelling arguments against the use of mercurial algicides, and sufficient, in itself, to sustain cancellation orders for the registration of Algimycin products.

The committee further recommends that all appropriate agencies of the Federal Government mobilize forces so as to mount a concerted, coordinated campaign against the unnecessary contamination of man's ecosystem with mercury and its compounds. The elimination of mercury-containing algicides only slightly reduces the environmental burden, and will have little impact unless all known and potential sources of mercury are controlled.

Section II - Efficacy of Mercurial Algicides and Non-Mercurial Substitutes

Algal growths in swimming pools are common occurrences in many private, residential-type swimming pools located outdoors. The presence of these plankton in swimming pool water is not consistent with good design and proper operation of swimming pools. Algal growths in swimming pool water are usually indicative of:

1) improper design and/or location of the inlets and outlets as to provide poor circulation of the water through the pool;

2) lack of continuous maintenance of a residual amount of the disinfectant in the swimming pool water so as to maintain bactericidal conditions in all areas of the swimming pool at all times;

and/or

3) inadequate maintenance and cleaning of the swimming pool.

The presence of algal growths in swimming pool water is dependent also upon the presence of sufficient nutrient materials, particularly phosphates and nitrates, in the water to support the growth of microscopic plant and animal life. Some community water supplies have relatively high levels of these nutritive compounds naturally. Continuous use of swimming pool water over a period of several months with only a small volume of make-up water added, usually results in the provision of sufficient nutritive materials to support algal growths.

Most algal growths require sunlight or a very high level of artificial illumination. Most outdoor swimming pools are located so that all or a major portion of the water surface is exposed to direct sunlight. Hence, the sunlight requirement for algal growth is provided.

The most common condition, and the most difficult to correct, which leads to algal growths in swimming pool water is the failure to maintain continuously in all areas of the pool a residual level of the disinfectant sufficient to be bactericidal. Strong sunlight destroys quickly the residual portion of most disinfectants used in swimming pool water treatment. Also, most private, residential-type swimming pools are not equipped with devices to permit continuous application of the disinfecting chemical. Without such apparatus, it is impractical, if not impossible, to maintain continuously in all areas of the swimming pool a residual concentration of the disinfectant of any detectable amount, much less of a level that is bactericidal and algicidal or algistatic.

There is, therefore, a practical need to apply an algicidal chemical to the water of a large number of swimming pools on a regular basis to prevent the growth of algae. From the public health point of view, there is a need to keep swimming pool water relatively free of algae. Algae interfere with the disinfecting action of the bactericidal agents used in swimming pool water treatment. Usually, a greater amount of the bactericide is needed to achieve a satisfactory level of disinfection. Algae may contribute to accidental injury as

they may cause the bottom, side-walls, steps, etc. to become slippery. Also, algae, if present in sufficient numbers, may cause the swimming pool water to become opaque. This condition may contribute to injury or drowning by the inability to see someone in the water who may need assistance. While the presence of algae in swimming pool water is indicative of poor or inadequate design, operation, and/or maintenance, practical considerations make it necessary to accept the need for the routine application of algicides to swimming pool water in many instances.

There is no question that compounds containing phenylmercuric acetate are effective algicides in swimming pool water. However, there are many other compounds that are considered to be equally effective. For example, many of the quaternary ammonium compounds, if used properly, are effective in the control of algae in swimming pools.

It is also possible and practicable to use periodic (once every 7-10 days) "super-chlorination" as a means of controlling algae in swimming pools. The benefit of "super-chlorination" is not limited to control of algae. "Super-chlorination" is a desirable practice to inactivate resistant bacteria, viruses, and other microscopic life and to reduce the concentration of chloro-ammonia compounds in the swimming pool water. These compounds frequently cause eye irritation and have reduced efficiency as a bactericide.

In summary, it may be said that for practical reasons, there is a need for algicides in swimming pool operation, particularly for use in many private, residential-type pools. However, there are

"safe" compounds that may be used to control algae. Similarly, there is a method of swimming pool operation, namely periodic super-chlorination, that will control algal growths in swimming pools under most circumstances. Super-chlorination may be used in conjunction with other algicides to obtain greater efficiency. It is acknowledged that compounds containing phenylmercuric acetate, such as "Algimycin 200" and Algimycin 300", are effective algicides in the treatment of swimming pool water, but it must be acknowledged also that phenylmercuric acetate compounds are not superior to other agents or processes. A number of effective algidical agents is listed in Appendix D1. Additional information concerning the effectiveness of algicides is presented in Appendix D2.

Section III - Risks to Handlers and Swimmers

There appears to be no clinical or laboratory evidence that phenylmercuric compounds, when used properly and according to instructions in swimming pools, constitutes a health hazard to either swimmers or handlers. An epidemiologic and health status study of workmen exposed to phenylmercuric compounds for as long as six years has demonstrated no evidence of adverse health effects except cutaneous reactions which were not classified.[1,2] It is very likely that these were primary irritant reactions, since the degree of exposure was such that this type of reaction would be expected. Studies, which cannot be regarded either as adequate or complete, of swimmers and users of PMA as a swimming pool algicide have not revealed any adverse health effects.[3] However, phenylmercuric compounds when used as weed killers, contraceptive agents, and topical anti-infectives, have been reported to cause allergic contact dermatitis.[4] Among the allergic dermatoses, cases of cell mediated hypersensitivity of this kind to phenylmercuric compounds are rare problems. There is also one well documented case in the literature of allergic asthma and urticaria from phenylmercuric proprionate in a person with a previous history of atopy.[5] It would appear, then, that both cell mediated and immediate types of hypersensitivity are infrequently provoked but known to occur. Such cases have not been reported among swimmers in pools using PMA as an algicide or handlers of PMA used as a slimicide for industrial cooling systems.

On the other hand, mercurial algicides cannot be considered to be entirely innocuous. The number of swimming pools in the United States

continues to increase yearly. For many people, exposure to waters treated with mercurial algicides has become a frequent event, repeated periodically over a period of many years. Dose-effect and time-effect data are not available. Total intake of mercury must be considered. There are multiple avenues for intake (e.g., inhalation, ingestion of pool waters, absorption through intact or abraded skin). Whatever amount is absorbed by these routes is simply added to the total body burden of mercury derived from an already contaminated ecosphere. Whether this additional exposure to mercurial algicides will prove to be injurious to various organs and tissues is an unanswerable question at this time. The question certainly merits attention, for mercurials are persistent in human tissues and may accumulate to dangerous levels especially in individuals whose renal function is impaired.

Section III - References

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3. Wisconsin Alumni Research Foundation: Algimycin 200 in Swimming Pools, Exhibit 7.

4. Morris, G. E.: Dermatoses from Phenylmercuric Salts. Arch. Environ. Health 1:53-55, 1960.

5. Matthews, K. P.: Immediate Type Hypersensitivity to Phenylmercuric Compounds. Am. J. Med. 44:310-318, 1968.

Section IV - Contribution to Environmental Pollution and the Need for Control

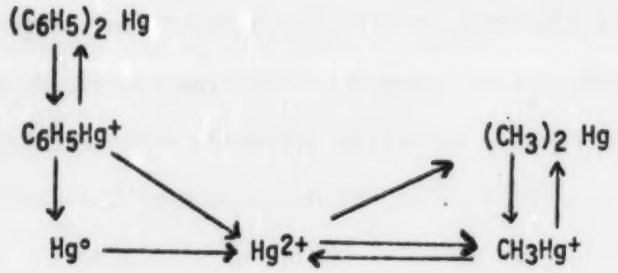
There is now overwhelming evidence that man has contributed significantly to the increasing amounts of mercury found in the environment, particularly in water, foods, and air.[1] In streams and oceans, the levels reached are such as to render certain fish inedible, and in some countries undesirable concentrations of mercury are found in staple foods, such as rice, fruits, eggs, and meat. Since inorganic mercury may be transformed by anaerobic microbial systems in the sediments of waterways to methylmercury, both discharges of methylmercury as well as inorganic mercury into streams, estuaries and oceans, contribute significantly to the depot of methylmercury to the earth's waters. There is convincing evidence that phenylmercuric compounds may be converted by vertebrate biological systems to the inorganic form and then by microbial metabolism into methylmercury. Hence, phenylmercuric compounds which are eventually discharged from sewer outflows into streams or other bodies of water probably add to the depot of methylmercury in our waters. At this point in time it is, therefore, urgent that all controllable sources of mercury, including phenylmercuric compound uses, be eliminated or maximally reduced. Mercurial algicide is an identifiable and an easily eliminated source of contamination. While its use may represent a minor item in the world's total use of mercury and a small contributor as compared with the mercury used in chloralkali plants, electrical equipment, and exterior paints, it is essential that phenylmercuric

discharges as well as the major contributors to mercury contamination of the environment be eliminated. It is essential that a coordinated effort to avoid discharge of mercury compounds into water, air, or landscape be undertaken. Phenylmercuric acetate may be eliminated by substituting equally effective compounds which are less toxic for man and animals. For this cogent reason above, the registration of PMA as an algicide for swimming pools and slimicide for cooling systems be cancelled.

If algicides are needed in a swimming pool, it is likely that chlorination is not - or cannot be - effectively utilized (see Section II). If chlorination is not effectively used, there is likely to be a host of bacteria in the pool waters. This is an important observation in any consideration of the mobility of mercury in the environment. It is the microbial transformation of inorganic mercury to methylmercury that so stunned scientists and demanded a new look into the whole mercury problem. It now appears that all forms of mercury may be directly or indirectly capable of conversion to methylmercury.[2] It has even been stated that certain bacteria appear capable of converting mercury compounds into metallic mercury vapor.[3] Insofar as the phenylmercurials used in swimming pools is concerned, Jernelov suggests that they are more efficient sources of mercury for subsequent methylation than is inorganic mercury.[4]

In evaluating the mobility of mercury in the environment and its ecological effects, it is necessary to look at the transforming

reactions that occur. For phenylmercury, Jernelov[4] cites the following:



The above conversion of phenylmercury to mono- and dimethylmercury in bottom sediments has been demonstrated. In this work; however, Jernelov notes that it has been very difficult to quantitatively repeat these experiments. This may be a manifestation of the loss of the more volatile dimethylmercury and perhaps other volatile intermediate forms. A great deal of the mercury "cycle" needs yet to be pieced together. We do not know all the environments in which methylation can occur.

Phenylmercury, when used in swimming pools for algae control, must be repeatedly brought up to strength.[5] Quite obviously, mercury is lost from the pool. Some may be volatilized directly to the atmosphere. Some will be splashed out onto the ground. In some locations, swimming pool waters can be discharged directly into a sanitary sewer system, thence going to the sewage treatment plant. In other locations it is possible to get a permit to empty a swimming pool into a stormwater drainage system. The important point is that the swimming pool is <u>not</u> a mercury sink - mercury

moves from the pool into the environment.

Although it has been stated that phenylmercury is an efficient form of mercury for subsequent methylation, mercury need not be in the phenyl form to migrate. Jonasson and Boyle of the Geological Survey of Canada suggest that mercury can migrate as sulfate, nitrate, various chloride complexes, carbonate complexes, hydroxide complexes, ammonia complexes, and as a variety of chelated and other organo metallic complexes.[6]

Although the quantification of the various pathways followed by mercury in the environment requires much additional study, available evidence indicates that little, if any, methylation occurs in soils.[2] However, Thompson, in his chapter on Airborne Mercury[7], states that both dimethylmercury and elemental mercury are volatile at ordinary outdoor temperatures, and that atmospheric variations might be associated with warming and drying of the soil. Hence, mercury deposited on land may not methylate directly at that point, but some will certainly evaporate and be transported to aquatic environments where methylation can proceed. Thompson cites unpublished data from Sweden showing the concentrations of mercury in precipitation, varying from a December low of 0.08µg/l to a July high of 1.45µg/l.

It is characteristic of mercury that water concentrations are seldom high. The waters of Minamata Bay - so seriously affected by pollution - contained only 1.6 to 3.6 ppb. Surveys in the U.S. show mercury to be generally associated with suspended particles.

Oceanic mercury is generally present as an anionic complex ($HgCl_4^{2-}$) which does not have so pronounced a tendency to adhere to particulates as do forms of mercury found in fresh waters.[3] Even today, most waters of Sweden need not be monitored.[8]

Attempts have been made to establish limits or standards for mercury discharged to aquatic environments. These have revealed that the mercury compounds tested were quite toxic even at low concentrations, and a level of no effect is difficult to arrive at. For example, ethylmercury at 60 ppb (parts ethylmercury per billion parts of water) was found to be lethal to marine phytoplankton, but as little alkylmercury as 0.1 - 0.6 ppb measurably reduced photosynthesis and growth. In another study, goldfish exposed to mercuric chloride at 820 ppb died in seven days, but only two days exposure to 3 ppb impaired their "learning".[3] Harriss et. al., after their studies on phytoplankton, concluded that effects below 1 ppb must be determined in order to establish adequate water quality standards.[9] By comparison, drinking water standards in both the U.S. and the U.S.S.R. currently recommend a value of 5 ppb.

Swedish studies (Johnels and Westermark) have documented the increasing mercury content of the biosphere. In this unique work, the accumulation of mercury in feathers of the goshawk in both freshly killed birds and in museum collections covering a period of more than 100 years shows nearly constant mercury levels from the middle 1800's until 1940. In 1940, alkylmercury seed dressings were first used and the mercury concentration in feathers began an

upward trend to a level 10 - 20 times that of the constant period.[10]

Most of the mercury found in animal tissues is methylmercury. Other forms of mercury are able to pass into the methyl form in nature owing to microbial action in bottom sediments. The process is not well understood and requires far more study to determine the conditions that permit methylation and demethylation and the rates at which these processes occur. It is evident, however, that methylation is a common and natural occurrence.[8] Jernelov[4] states that if the rate of conversion of inorganic to methylmercury is the rate-determining step in the removal of mercury from bottom sediments, it is calculated that this removal would take from 10 to 100 years.

Methylmercury is the form best absorbed and most slowly lost from animal tissues. It accumulates in the brain where it destroys cells and causes neurotoxicity. It passes the placenta and damages the fetus. It accumulates so that repeated minute doses over prolonged periods can disable. These points are documented for man but apply more pointedly to animals, because animals living in contaminated areas are exposed to polluted food such as man only rarely is, and because some animals excrete mercury more slowly than does man. Animals that live in polluted water can pick up much mercury directly from the water - in some instances more than they get from their food.[8]

The mercury contamination in bottom sediments of waterways constitutes a depot which, through the methylating process, represents a continuing source of methylmercury. All discharges of inorganic and organic mercury can presumably contribute to this depot.[11]

Phenylmercuric compounds used in swimming pools for algae control are no exception.

That radiation causes genetic damage has been known for many years and the need for appropriate protection of the American population has been widely recognized. The principle that exposure to radiation be kept at the lowest practical level and that there be no additional exposure unless the harmful effects are outweighed by anticipated benefits is now well established in the public policy of this country. The concern is not only for the health and welfare of contemporary populations but even more important for future generations. There is reason to fear that some chemicals and drugs also may constitute as important a genetic risk, possibly a more serious one, as radiation. In humans, genetic defects are not uncommon and are a serious problem. All agents that are introduced into the environmental microcosm should be seriously considered and examined for mutagenic effects.

It has been stated on page 567 of "Report of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health," Parts 1 and 2, published by the U.S. Department of Health, Education, and Welfare in December 1969,[12] "among the plethora of new chemicals in our increasingly complex environment, a number are already known to be mutagenic, i.e., capable of producing genetic damage. When genetic damage occurs the burden of hereditary defect in future generations is increased.

One potential genetic hazard comes from pesticides. Although

we can point to no pesticide now in wide use that has been demonstrated to be mutagenic, the overwhelming majority have, however, not been adequately tested, although appropriate methodologies are now available.

We define mutations as any inherited alteration in the genetic material. Such alterations in exposed individuals may lead to cancer and to teratological effects. Our main concern, however, is for their descendants; for such changes lead to a wide range of abnormalities, mental retardation, physical and mental disease, and all the other inherited weaknesses and debilities to which man is susceptible. Since these effects will occur in future generations and may be apparent only many generations removed, by the time the effect is noticed, the damage is already irreversible. It is therefore urgent that any mutagenic chemicals to which the population is exposed be promptly identified."

In fact, that report went on to recommend that "all currently used pesticides be tested in the near future... And no new pesticides should be registered until tested for mutagenicity."

There has been a substantial amount of evidence to indicate that mercury compounds, including those used as pesticides, also induce chromosome breaks and mitotic aberrations.[13] The reasons for these effects of mercury are not known, except that mercury does bind to the purines in DNA and this, of course, could change the genetic message that is synthesized from the DNA template.

On page 39 of the report entitled "Mercury in the Environment: The Human Element" by Wallace, Fulkerson, Shults and Lyon (ORNL NSF-EP-1)[14], the question of mercury as a mutagen is presented.

In a section entitled Genetic and Long-term Effects of Mercury Exposure, it is stated "cytological investigations on plant and animal cells have shown that mercury compounds give rise to chromosome breakage and act as inhibitors of the mitotic spindle mechanism, with the result that polyploidy or abnormal distribution of single chromosomes occurs. As spindle inhibitors, methyl and phenylmercury compounds are more potent than any other substance known, including colchicine. Such preliminary observations would imply that both an increased genetic load of mutations within living populations and long-term effects such as carcinogenesis may be influenced by mercury in the environment." The report goes on to state that further investigations should also be undertaken on the various mercury compounds used in pesticides and pharmaceuticals.

Organic compounds of mercury have been found experimentally to produce genetic mutations and chromosomal aberrations in certain systems of plants and Drosophila.[13-16] Such changes, however, have not been demonstrated in mammals as yet. C-mitosis, defined as the characteristic appearance of chromosomes which have contracted more than is usual for mitotic metaphase and lie scattered within the nucleus, has been demonstrated in cells of Allium cepa exposed to concentrations of phenylmercury compounds at levels as low as 15×10^{-7}M (about 0.05 ppm). Some of these compounds also cause c-mitotic tumors, and hook-like growth of the roots is also observed. Methylmercury and phenylmercury are among the most active c-mitotic agents known, being 200-1000 times more effective than colchicine.

In a study with Drosophila melanogaster[15,16], treatment of female larvae and adults with phenylmercury acetate resulted in a significant increase in the number of exceptional daughter offspring (XXY), showing irregularities of meiotic chromosomal disjunction. Chromosomal effects and developmental disturbances (mutant gene and outstretched and bent wing) occurred. There has only been one report on mammals. These studies with inbred CBA mice failed to demonstrate dominant lethal mutations after administration of organic mercurial compounds.[15] However, although pregnant female CBA mice that received single doses on day 10 of the gestation period did not appear to be affected, there was in these animals a high frequency of resorbed litters and an increased percentage of dead fetuses. It should be pointed out also that Skerfving et. al.[17] showed a statistical increase in chromosomal breaks in blood cells of human consumers of large amounts of fish containing methylmercury. No such study is available for phenylmercuric acetate. Methylmercury phosphate has been shown to have teratogenic effects in pregnant mice resulting in a 31.6% incidence of cleft palate.[18] It is obvious that in the case of phenylmercuric acetate there have been very limited, if any, significant experiments dealing with the mutagenic and teratogenic effect of this agent with the exception of the work of Ramel.

It must be kept in mind that phenylmercuric acetate does produce genetic damage in Allium cepa roots and Drosophila and, although the genetic effects have not been studied to any extent in mammalian

systems, they may occur. It is also well to keep in mind that when swimming pool water containing phenylmercuric acetate is emptied, the mercury compound enters the ecosphere, and by simple forms of life taking it up, mutations are not only possible in these simple life forms but also in the higher forms of life that eventually ingest the simpler forms.

Thus because of the known genetic effects of phenylmercuric acetate in Allium cepa and Drosophila, even though the experiments are limited in number, a strong possibility exists that this agent would have harmful genetic effects in humans.

The present problem regarding environmental Hg contamination has stemmed from a lack of understanding that discharge of this element in its various forms into ecosystems presented a potential for unforeseen transformations of a hazardous nature. This was particularly true of the discharge of the elemental, metallic form, which had been considered as relatively chemically - and therefore biologically - inert. The elemental form is known to be under most conditions inaccessible to biological systems except in its volatilized or vapor state; therefore being relatively unavailable to living systems, metallic mercury was considered to be of low toxicity with the exception noted regarding its vapor.

A parallelism between our consideration of the aryl mercuric forms of mercury as compared with elemental contamination is discomforting. That is, once again, the aryl mercury compounds are of relatively low toxicity compared to the alkylmercury compounds.

furthermore, whereas the literature is replete with human and animal toxicity data concerning deleterious effects of alkylmercurials, there are relatively few reports of similar problem of toxicity due to the aryl forms - with the exception of some cases with suicidal intent. Thus there could be a similar tendency to write off concerns with the aryl mercurials as a class, if direct human and animal toxicity were our sole criteria.

It is hoped that the lessons learned regarding elemental mercury's biotransformation will not be forgotten, especially in view of nature's almost limitless capabilities for chemical synthesis and transformation. It would appear that presently available information provides us with more than a suspicion that the aryl mercurials may be transformed to mono- and dimethyl mercury in experimental systems. Swedish investigations[4] have noted that discharge of phenylmercury appears to have a more pronounced effect upon mercury build-up in fish than is the case for discharges of inorganic mercury.

With such a strong suspicion, it would appear prudent to delimit the discharge of aryl mercurials through relatively uncontrolled use into the environment. Certainly such discharge increments of the aryl mercurial slimicidal compounds represents one additional potential source for methylmercury formation and entry into the food chain. This would argue for discontinuance of the use of this class of compound wherein its use is uncontrolled and its discharge considerable in magnitude.

Such a position should be balanced against the possible harm

to society of making the compound unavailable. In another portion of this report the question of appropriate substitutes for the use in question is considered: it appears that equally effective non-mercurials are available to achieve the same ends. Accordingly, the loss to society of Algimycin products would appear to be minimal compared to the incremental burden these phenylmercurials place upon the environment.

However, if we are to consider the question in its proper perspective this discharge of phenylmercuric acetate is a relatively minor source of environmental contamination. Therefore, for the proposed action to have any degree of consistency, if the proposed action stems from a desire to minimize ecosystem mercury burdens, then other more extensively used phenylmercurials should be similarly removed from uncontrolled use. Otherwise, the gain to society of stemming discharge of mercurial algicides from swimming pools would seem to be minimal.

At this point it is most appropriate to cite the major recommendations of the special report to the Secretary's Pesticide Advisory Committee of the Department of HEW of November 1970 on the Hazards of Mercury:[1]

> "5. CONTROL.
>
> All controllable sources of mercury contamination should either be eliminated or maximally reduced.
>
> Thus, (1) the use of all alkylmercury pesticides should be terminated and all other mercurial pesticides should be severely restricted to usage on the basis of demonstrated need only. Safe substitutes should be sought for those remaining in use and not now possible to eliminate.

(2) Further safeguards should be developed for the manufacture, packaging, distribution and field use of seed treated with organic mercurials and for the disposal of unused treated seed and its containers to avoid mercurial poisoning through accidents or misuse of such materials.

(3) All industrial users of mercury, particularly those operating chlorine and alkali production plants and those using mercury catalysts, should be required to reduce their discharges of mercury into the environment to levels approximating background levels.

(4) Other sources of mercury contamination or exposure - for example discarded electrical equipment, chemicals, paints, cosmetics, pharmaceuticals, sewage, and fossil fuels - must be identified and brought under control. The urgency of this is emphasized by the circumstance that although mercury in any form is hazardous, all forms of mercury have the potential to be converted into the highly toxic form of methyl. mercury."

The control of mercury contamination from all manmade sources requires the coordination of efforts by every government agency empowered to regulate the use and discharge of mercury. In order to fulfill the recommendations of HEW Committee, it is urgent that plans be developed collectively by the several national health agencies responsible for the safety of industrial and consumer environments - air, water, solid wastes, agricultural uses, forestry uses, food, drugs, cosmetics, etc. - for the surveillance and control of the uses and environmental contamination of mercury. In this planning, it is essential that not only the adverse health effects on man be considered, but the effects on all forms of life essential to man's ecosystem. It would appear, then, that effective liaison for planning and control be developed by the FDA, EPA (for air, water,

solid wastes, and pesticide regulation), NIOSH and the Department of Labor, NIEHS, etc. Not until such working liaison is established will it be possible to reduce the hazards of environmental mercury to man and his ecosystem.

Section IV - References

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Section V

Appendix A - Members of the Mercury Advisory Committee

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Section V

Appendix B - Discussants at May 3 and 4 Meeting

Mr. James F. Stern, Attorney
Executive Vice President,
Great Lakes Biochemical Company

Dr. Robert M. Stern, President
Great Lakes Biochemical Company

Dr. Paul O. Nees
Wisconsin Alumni Research Foundation

Dr. Leonard J. Goldwater

Dr. George P. Fitzgerald

Section V

Appendix C - EPA Staff at May 3 and 4 Meeting

Mr. Harold G. Alford, Acting Director
Pesticides Regulations Division

Mr. David L. Bowen, Secretariat
Pesticides Regulations Division

Mr. Edward Carter
Pesticides Regulations Division

Mr. Robert Caswell
Pesticides Regulations Division

Mr. Joe Cummings
Pesticides Tolerances Division

Dr. Lamar Dale
Pesticides Regulations Division

Mr. Thomas Kemp
OGC

Miss Harriett Lewis, Stenographer
Pesticides Regulations Division

Dr. Thomas McClure
Pesticides Regulations Division

Dr. Ernest Walker
Pesticides Regulations Division

Mr. P. W. Whiteaker
Pesticides Regulations Division

APPENDIX D1

Chemicals Used for Algae Control in Water Cooling Towers

Quaternary Ammonium Compound

Quaternary + TBTO

Na salt of pentachlorophenate

K salt of "

Na salt of trichlorophenate

K salt of "

Mixtures of phenates

Sodium ethyl mercury thio salicylate

Potassium permanganate

Copper sulfate chelated

Chlorine as cyanurates

Na hypochlorite

Dehydroabietylamine acetate

Na salt of O-benzyl-p-chlorophenol + K and Na salts

K salt of " "

Chlorinedioxide

1,3-dichloro-e,5-dimethyl hydantoin

Dodecyl guanidine hydrochloride

Methylene bis thiocyanate

Bis trichloro methyl sulfone

APPENDIX D2

BOYCE THOMPSON INSTITUTE FOR PLANT RESEARCH, Inc.
1086 NORTH BROADWAY
YONKERS, N. Y. 10701

GEORGE L. McNEW
DIRECTOR

MAY 10 1971

May 7, 1971

Dr. Edward J. Cafruny
Dept. of Pharmacology
Medical College of Ohio
Toledo, Ohio 43614

Dear Dr. Cafruny:

Dr. Susskind asked that I write you regarding the potential hazard to the environment from use of phenylmercuric acetate as an algicide for swimming pools. My experience with this material has been primarily for use as a seed disinfectant and spray material for eradication of apple scab (Venturia inaequalis) on foliage early in the season before fruit began to enlarge.

I do know, however, that the material has been used very satisfactorily under the name of Algimycin for treating swimming pools. If I recall correctly, a solution of 5% or less is diluted to about .09 ppm. of water. The material quickly (8 to 12 hours) reduces in concentration to about 10% of this level. Presumably this is due to its rapid uptake by algae or other microorganisms but I assume a minor source of loss - and a very inconsequential one - would be by volatilization. The residual amounts discharged when the pools are cleaned could go into drainage lines or into soil. In my opinion it would be quickly bound to organic matter. The only potential hazard I could visualize would be its conversion to methyl mercury but it would seem to be of such minor occurrence that it should not be of substantial hazard.

As you know, there are a number of fungicides that are algicides which would be free of toxic effects. For many years copper sulfate was used in ponds for this purpose. I believe Phelps Dodge Co. has a substantial file on this use. Another prospect would be Dichlone (Phygon of U. S. Rubber Co.) or 2,3-dichloronaphthoquinone. I know the Naugatuck Chemical Division of U. S. Rubber Co. made some extensive tests against algae in Wisconsin lakes when eutrophication set in about 20 years ago. I do not recall who collaborated with them at the University but I suspect Dean Glenn Pound of the College of Agriculture might recall the individual. I suspect the copper would cause some minor irritation in pools and Dichlone might cause skin irritation since an occasional rare individual reacts to it. A very logical fungicide would be Captan but I know of no tests against algae.

Sincerely yours,

George L. McNew
Managing Director

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APPENDIX D3

ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE
5555 Ridge Avenue, Cincinnati, Ohio 45213
May 7, 1971

Mr. David Bowen
Secretariat
Mercury Advisory Committee
Pesticides Regulations Division
Environmental Protection Agency
Room 2144
South Agricultural Building
12th and Independence, S.W.
Washington, D. C. 20024

Dear Mr. Bowen:

In the past, the Division of Water Hygiene, WQO, EPA, (formerly the Bureau of Water Hygiene, U.S.P.H.S.) has been asked by other federal agencies and by some state health agencies to evaluate the toxicity of phenyl mercuric acetate (PMA) for use in swimming pools and to render an opinion as to its acceptability from a public health standpoint. As the Division's toxicologist, I was assigned these evaluations. In each case, my professional judgement led me to conclude that PMA was not acceptable from a public health standpoint for use in swimming pools. The reason for my decision was based on the following:

1. The relatively high acute and subacute toxicity of PMA to experimental animals;

2. The degree of absorption of PMA via the cutaneous and gastro-intestinal routes of those individuals swimming in the PMA treated water, including the likelihood of ingesting the pool water while swimming;

3. The addition to the total body burden of mercury from the absorption of PMA;

4. The possible conversion of PMA to other more toxic forms of mercury by aerobic bacteria; and

5. Other less toxic algicides were available for use in swimming pools.

B452
5

Page 2 - Mr. David Bowen

Currently, the Drinking Water Standards Committee of the EPA is proposing a drinking water standard for mercury at 0.005 mg per liter (ppm). In recommending this limit, it is the intention of the Committee that the standard pertain to unintentionally present mercurials and that the limit should not constitute a license to deliberately add mercury to water which is for human use (i.e., drinking and bathing).

Sincerely yours,

Robert G. Tardiff

Robert G. Tardiff, Ph.D.
Chief, Toxicology
Division of Water Hygiene